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Signed R. Mahoney

Dated 22 November 1999

GB9823032.9

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

JIM LINDSAY LIMITED
13 Hill Street
ARDROSSAN
KA22 8HE
United Kingdom
Incorporated in the United Kingdom

[ADP No. 07782089001].

GB9823032.9

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

JAMES LINDSAY
25 Ardrossan Road
Saltcoats
Ayrshire
KA21 5BP
United Kingdom

[ADP No. 07309727001]

GEORGE WALTER ROBINSON
15 Shire Avenue
SPALDING
PE11 3FN
United Kingdom

[ADP No. 07309735002].

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Request for grant of a patent

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1. Your reference — P20188/HGR/GMU

2. Patent application number *(The Patent Office will fill in this part)* — 22 OCT 1998 — 9823032.9

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

James Lindsay
25 Ardrossan Road
SALTCOATS
Ayrshire
KA21 5BP

Patents ADP number *(if you know it)* 7309727001

George Walter Robinson
210 Park Road
SPALDING
Lincolnshire
PE11 1QZ

7309735001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention

"Method and Apparatus for Spraying"

5. Name of your agent *(if you have one)*

Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

373 Scotland Street
GLASGOW
G5 8QA

Patents ADP number *(if you know it)* 1198013

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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No

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Continuation sheets of this form	
Description	11
Claim(s)	0
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Drawing(s)	3

10. If you are also filing any of the following, state how many against each item.

Priority documents	–
Translations of priority documents	–
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	–
Request for preliminary examination and search *(Patents Form 9/77)*	–
Request for substantive examination *(Patents Form 10/77)*	–
Any other documents *(please specify)*	–

11. I/We request the grant of a patent on the basis of this application.

Signature Murgitroyd & Co. Date
Murgitroyd & Company 21 October 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

Graham Murnane
0141 307 8400

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METHOD AND APPARATUS FOR SPRAYING

The present invention relates to a method and apparatus for very low air pressure spraying. Particularly, but not exclusively, the invention is applicable to spray guns for the application of paint and like material surface treatments, particularly water-based paints.

The use of spray guns for application of paints is well known. However, it has been found that when water-based, high gloss paints are sprayed through a high pressure or conventional spray gun, the level of gloss is reduced. This is also true of the high volume-low pressure type of spray gun which operate at only 10psi air cap pressure.

Tests carried out at various pressures have shown that the loss of gloss is due to air bubbles rising to the surface of the paint as it dries. It has been found that the greater the pressure used to spray the paint, the more air bubbles appear. The cause of the bubbles is that dissolved air is being released from the water as the paint dries. The greater the air pressure when the paint is sprayed, the greater the volume of dissolved air and the greater the number of bubbles.

If the air pressure is low but the volume is high, gloss levels are reduced. To achieve the desired gloss levels with this type of paint it is necessary to design a spray gun that will operate at very low air pressures and very low air volumes. It must achieve acceptable levels of atomization, have sufficient energy to transfer the paint at an acceptable rate to the surface of the target, and compress the natural cone of spray into a useful fan pattern.

In the past, spray guns have used air pressures between 40 and 90 psi, and these high pressures cause a cushion of air to be formed on the surface of the product being treated. This cushion causes some of the sprayed material to bounce back and be displaced laterally by the following airflow to be lost in the surrounding air.

Accordingly, this type of spray gun is very inefficient. Rarely are transfer efficiencies greater than 40% and more often nearer 30%. The waste paint material produces unacceptable emissions of volatile organic compounds and leaves a solid residue which can remain floating in the air for some time. These can be highly toxic and damaging to the atmosphere and health. To overcome these problems, it is necessary to reduce the air pressure and air volume used in such guns. Therefore, the environmental requirements for an acceptable spray gun are similar to those required for achieving a good gloss in water-based paints.

If the air pressure is reduced on a spray gun that was originally designed for high pressure use, the turbulence and restrictions in internal air passages and the air cap cause a loss of air speed and a reduction in air volume. The result of this is low

paint transfer rates, poor atomization and an inferior paint finish. However, transfer efficiency is improved. If the air volume is increased while keeping the pressure low, the ratio of air to paint increases and the problems experienced with high pressure will return depending on the increase in volume.

Existing high pressure spray guns have been modified to operate at low pressures, but the complexity of the designs and the intricate interconnecting drilled passages do not permit good air flow. In an effort to overcome the poor performance, air cap ring gaps were increased, resulting in a substantial increase in air consumption. This type of spray gun has become known as the high volume-low pressure (HVLP) gun.

More specifically, in prior HVLP spray guns the means for actuating the control valves within the gun have had considerable shortcomings. For example, it is commonplace for the stem of the needle valve and its associated compression spring and housing to extend through the main air flow passage to the nozzle, thereby leading to significant restrictions in the air flow path.

Likewise, in order to provide a convenient means for actuating the stem of the air flow and fluid needle valves, the main nozzle of the apparatus is mounted on a forward projection of the apparatus so as to leave a free space to accommodate the arc of movement of the valve control trigger.

Moreover, since the same trigger operates both the liquid and air control valves, the progressive control from on to off operating characteristics of the air control valve can be restricted in certain operating

conditions where the liquid control valve has been manually adjusted to such a point that it affects the ability of the trigger to operate both valves simultaneously through the full range of movement.

The object of the present invention is to provide a method and apparatus for spraying paint and other surface treatment liquids, offering improvements in relation to one or more of the matters discussed above, or generally.

Accordingly, the invention provides a method and apparatus for spraying that addresses the limitations and inefficiencies of prior spray guns. As it may operate at pressures as low as 1.5psi in the air cap and at air volumes as low as 4cfm, energy savings are achieved. The very low pressures allow a very high transfer efficiency to be achieved which is an added advantage when used with paints containing volatile organic compounds.

The present invention permits the trigger to operate the air control valve and the fluid control valve simultaneously, without restricting the operation of either, regardless of the adjustment of the other. The stems of both the fluid control needle valve and air control piston valve operate in parallel to each other, yet independently of each other.

The above permits a straight, unobstructed, large diameter air passage to the air valve while also permitting a short, straight air passage to the air cap and a large diameter fluid passage.

In addition, by offsetting the air passages, gas acceleration may be achieved by means of a vortex

created by the gas passing through these passages. With gas acceleration in the head portion of the apparatus, the increased speed of the gas created by the vortex leads to an increase in air speed at the nozzle and thereby an increase in material sprayed by the gun. Therefore, although gas is introduced to the apparatus from a compressor at relatively low pressure, by having the air passages arranged in the offset position a gas acceleration is achieved with a consequential increase in efficiency at the nozzle. Moreover, further gas acceleration can be achieved by providing a pair of adjustable, apertured sleeves which can either increase or decrease gas flow into the vortex from the trigger valve depending on the alignment of the apertures.

The features of the present invention:

i) reduce the compressed air volume required;
ii) reduce the pressure of said compressed air;
iii) reduce energy losses;
iv) improve exit air speed;
v) increase depression at the fluid nozzle; and
vi) reduce resistance to fluid flow.

The internal surface area of the air passages is approximately 50% less than a representative selection of spray guns currently available.

The trigger to air cap air passage length is 75% less than with the representative selection.

Total air passage length is approximately 40% less than with the representative selection.

Input air pressure is 75% lower than the average of the representative selection.

Air volume required is approximately 50% lower than the average of the representative selection.

Depression at the fluid nozzle is approximately 30% greater than the representative selection.

According to a first aspect of the invention there is provided a spray gun for spraying a fluid, said spray gun having a gas input, a first communicating passageway connecting said input to a trigger valve mechanism, and a second communicating passageway connecting said trigger valve mechanism to a nozzle; wherein said second passageway is provided with a stepped portion therein so that a gas vortex is created therethrough.

Preferably, said second passageway is offset from said first passageway.

Preferably, said second passageway is substantially conical in shape.

Preferably, said second passageway includes an inlet and an outlet, wherein said passageway is tapered from said inlet to said outlet. Preferably, said taper is between 1 to 15°.

Preferably, said stepped portion of said second passageway comprises a ledge whose width tapers up to a maximum of 10% of the radius of said second passageway at the level of the stepped portion.

Preferably, said second passageway has a radius of curvature at said outlet so as to provide gas to the nozzle in a substantially horizontal direction.

Preferably, the longitudinal axis of said nozzle extends across said second passageway. Preferably, the axis of symmetry of said ledge is offset from said longitudinal axis of said nozzle, thereby inducing a vortex in the air flowing through said passageway.

According to a second aspect of the invention there is provided a spray gun for spraying a fluid, said spray gun having a gas input, a first communicating passageway connecting said input to a trigger valve mechanism, and a second communicating passageway connecting said trigger valve mechanism to a nozzle; wherein said second passageway is axially offset from said first passageway and is substantially conical in shape, wherein second passageway includes an inlet and an outlet and is tapered from said inlet to said outlet at an angle of taper of between 1 and 15°.

Preferably the trigger valve mechanism comprises a first valve means for the supply of a gaseous propellant, the spray gun further comprising a second valve means for the supply of said fluid to be sprayed, and a trigger means, whereby said trigger means is adapted to operate both of said first and second valve means.

Preferably, the spray gun is provided with a nozzle controlled by a liquid control needle valve and an annular air jet controlled by a piston valve. The piston valve may be tapered or parallel. In addition, an air control valve stem is provided which is connected to the axially-sliding piston valve and operated by the trigger means.

Preferably, the liquid control needle valve is also controlled by said trigger means via an axially-sliding

sleeve or slipper member situated on a rearward portion of the spray gun housing. Preferably, it is also provided with a rotational flow adjustment means to adjust the flow rate of the liquid.

Preferably, the spray pattern of the nozzle is regulated by a regulating valve wherein a pair of side jets are utilised to regulate said spray pattern.

Preferably, there is provided an air passage which connects an air supply connector to the piston valve. The air control valve stem controls the flow of air through said air passage, with a spring returning said piston valve and air control valve stem to their initial positions.

Preferably, the liquid control needle valve has a stem member which is threaded at its rearmost extremity to accept the rotational adjuster. Preferably, said stem member is actuated externally by the trigger means, and is returned to its initial position by a return spring.

Preferably, the needle valve is supplied with the paint or material surface treatment by a pressurized material supply connector which distributes the material via a radial port to said needle valve. Alternatively, the material may be introduced to the apparatus from a gravity fluid reservoir fitted to the uppermost aspect of the spray gun via a radial port.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which :-

Fig 1 is a section through a spray gun according to a first embodiment of the invention having pressure feed

and offset air passages;

Fig 2a is a sectional view of a spray gun according to a second embodiment of the invention having offset air passages and a tapered upper air passage;

Fig 2b is a sectional view along line "A-A" of Fig 2a; and

Fig 2c is a sectional view along line "B-B" of Fig 2a, showing the stepped portion of the upper air passage.

As shown in Fig 1, spray apparatus 10 comprises a body or housing 12 having a nozzle 14, an air supply connection 16, a pressurized material supply connection 18, an air control valve stem 20, and a liquid control valve 22. A tapered piston valve 24 controls the supply of air to nozzle 14 in order to regulate the spray pattern.

Nozzle 14 is located by a threaded ring (not shown) fitted on a housing of body 12 and provides a central jet 15 controlled by liquid control needle valve 22, and an annular air jet 28 controlled by piston valve 24.

Air supply connection 16 is coupled to a compressor (not shown). Connection 18 is supplied by a reservoir (not shown) containing paint or like material to be sprayed.

Air control valve stem 20 connects to an axially-sliding piston 24 to effect progressive throttling of the air flow. The stem 20 is pushed by an operating trigger 40.

Liquid control needle valve 22 has a rotational adjuster 44 and is controlled by trigger 40 through a sleeve member 46 which slides on a rearward portion 48 of housing 12. The trigger is connected to the sleeve by a flange (not shown).

A regulating valve 52 is positioned whereby the jet produced by nozzle 14 is regulated from a natural cone to a fan pattern by air from side jets 17.

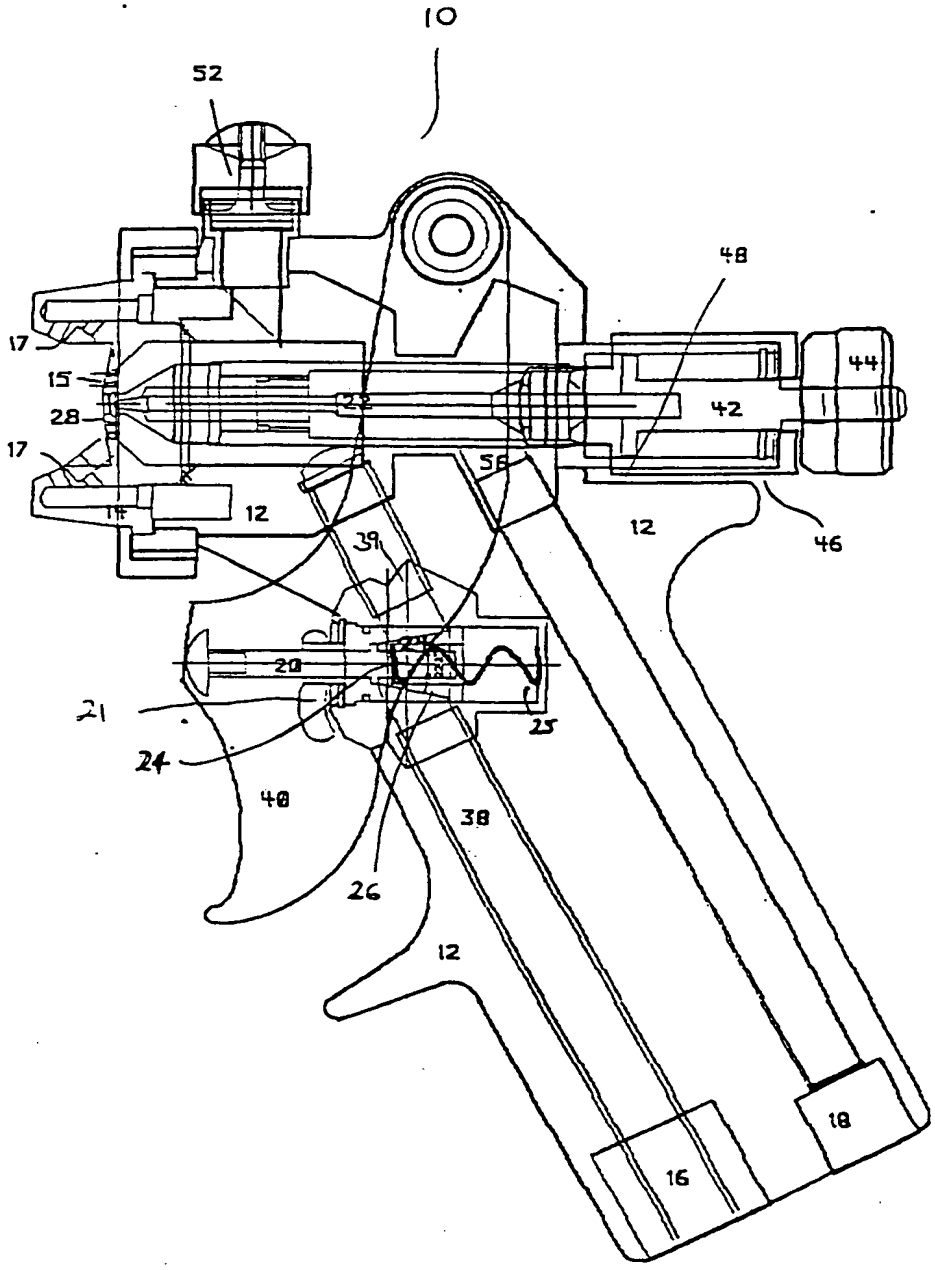
The air passage 38 connects the air supply connection 16 with the piston valve 24. The air control valve stem 20 controls the air flow through offset passages 38 and 39, where passages 38 and 39 are offset to create a vortex within passage 39, thereby accelerating the gas flow through said passage. A return spring 25 which returns the piston 24 and stem 20 to their extended position when released is also provided. Piston valve 24 has two apertured rotational sleeves 26 which can be adjusted by lever 21 to either line up, close off or partially close the apertures, thereby increasing or decreasing gas flow through valve 24 and offset air passage 39. Thus, the pressure in the gun can be regulated to offer variable pressure sprays.

Liquid control valve needle 22 has a stem member 42 which passes through sleeve member 46 and is threaded at its rearmost extremity to accept rotational adjuster 44. The rotational adjuster 44 allows fine position adjustment of the fluid control needle. Trigger 40 actuates the needle member externally of the housing 12. An internal return spring (not shown) returns the needle to its rest position. Liquid to be sprayed is fed to needle valve 22 from connection 18 via a radial port 56.

Figures 2a to 2c show views of an embodiment of the spray gun in which upper air passage 39 has been modified to assist the creation of the vortex within the passage 39. Figure 2b shows the tapering of the passage 39 to assist the acceleration of the gas therein. The best acceleration results have been produced when the tapering is between 1 to 10°. Figure 2c details the cross-section of the passage 39 at its inlet, wherein a stepped portion 50 is provided. For the most effective vortex, the stepped portion 50 should encompass approximately 10% of the circumference of the passage 39. The vortex is created in the passage 39 as the gas passes through the inlet of passage 39 over the stepped portion 50, which can be best seen in Fig 2b. As the gas passes over the stepped portion, the reduced area causes the gas to swirl in the passage, thereby creating the vortex which produces a gas acceleration upwards through the passage 39. The tapering of the passage 39 ensures that the vortex is sustained until it reaches the outlet of passage 39 at nozzle 15.

Aside from the amendments to the passage 39, this embodiment of the spray gun 10 is constructed and operated substantially in the same manner as the spray gun 10 of figure 1. In use, both embodiments are operated as follows:
The reservoir of material to be sprayed delivers the material to central jet 15 under the control of needle valve 22 where it is mixed with air delivered via air passages 38 and 39. The operation of the gun is initiated by trigger 40 operating air control valve stem 20 and liquid control valve 22.

FIG 1



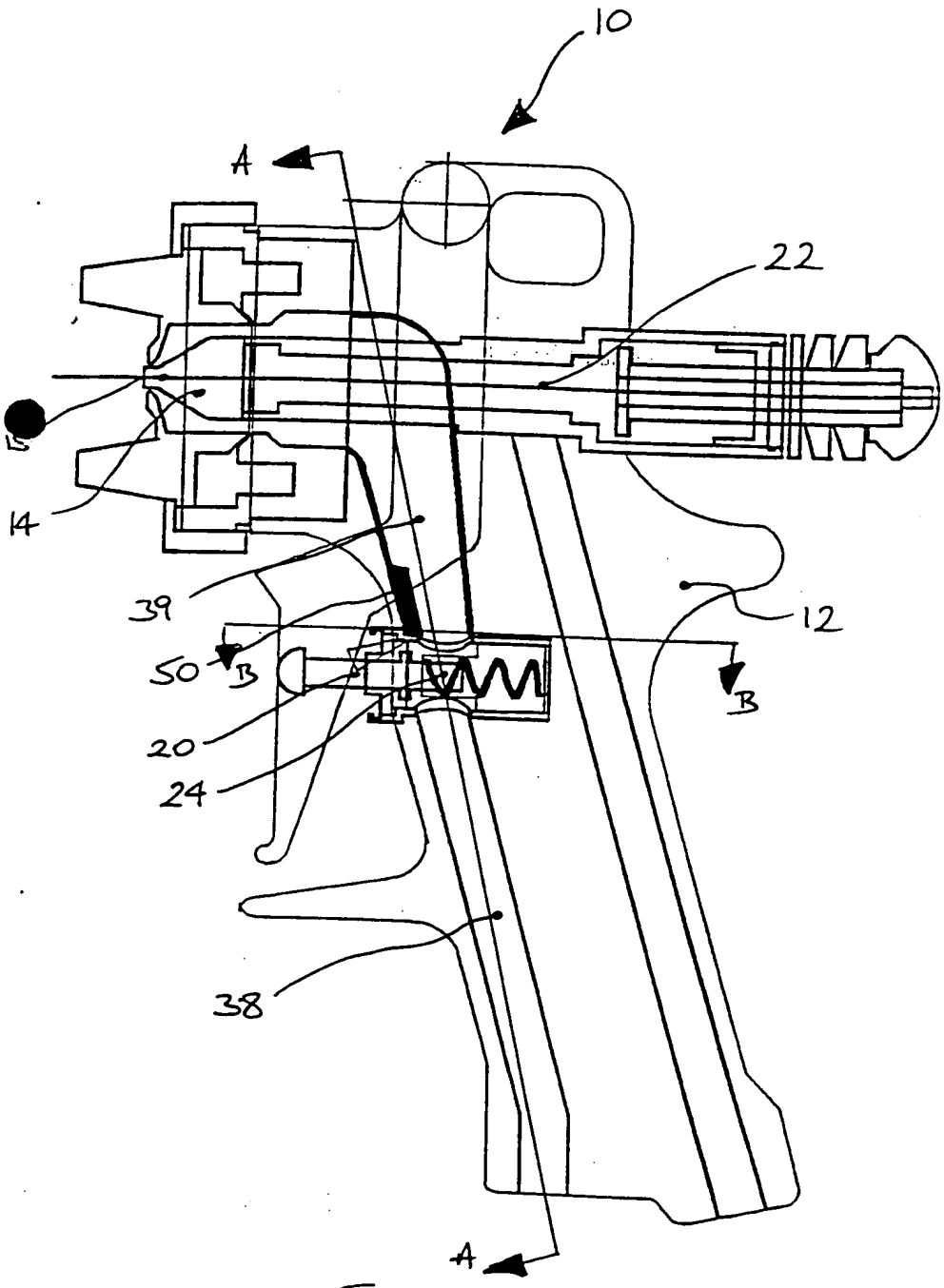


Fig. 2a

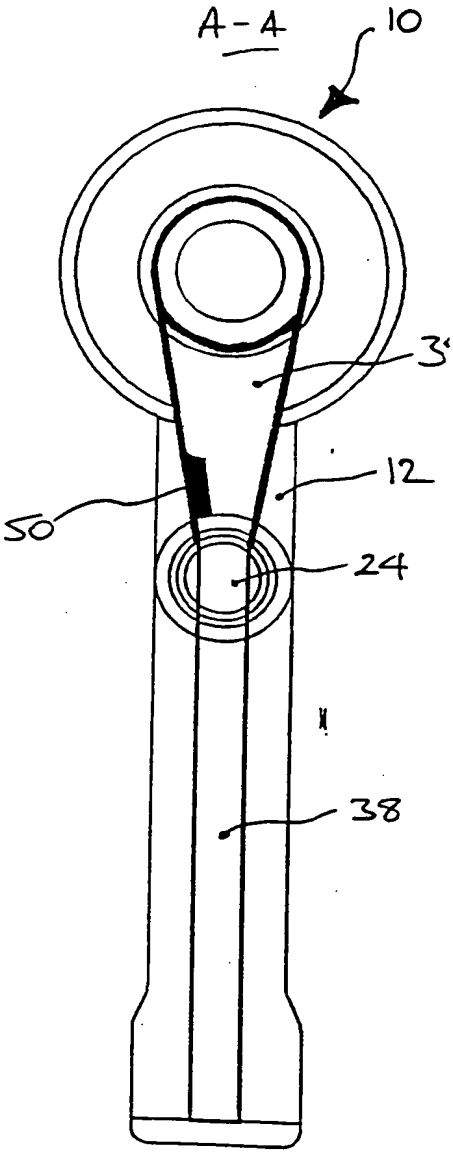


Fig. 2b

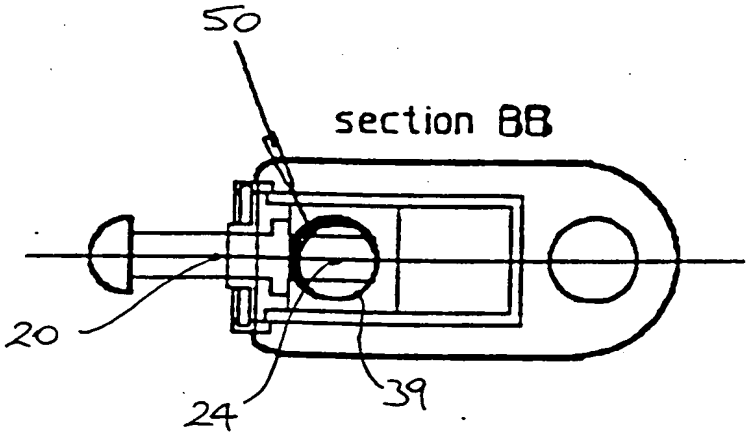


Fig. 2c

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